AIR FORCE
PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force STTR Program is with the Air Force Research Lab, Wright-Patterson Air Force Base, Ohio. The Air Force STTR Program Executive is R. Jill Dickman, (800)222-0336. **DO NOT** submit STTR proposals to the AF STTR Program Executive under any circumstances. Addresses for proposal submission and numbers for administrative and contracting questions are listed on the following page.

Technical questions may be requested using the DTIC SBIR Interactive Technical Information System (SITIS). For a full description of this system and other technical information assistance available from DTIC, please refer to section 1.5c of this solicitation.

The Pre-Solicitation Announcement (PSA), listing the full descriptions of the topics and the author of each, was issued electronically and in hard copy, after being announced in the Commerce Business Daily. Contact the AFOSR directly for information on future PSAs (see mailing address and phone number on the next page). Open discussions can be held with topic authors until 1 Mar 99 concerning technical aspects of topics. Small businesses that did not know about the PSA or did not participate in the exchange may find relevant questions or comments from these talks listed in SITIS, please refer to section 1.5c of the solicitation.

For each Phase I proposal, send one original and three (3) copies to the office designated on the following page. Be advised that any overnight delivery may not reach the appropriate desk within one day.

Unless otherwise stated in the topic, Phase I will show the concept feasibility and Phase II will produce a prototype or at least show a proof-of-principle.

<u>Air Force Fast Track</u>

Detailed instructions on the Air Force Fast Track and Phase II proposals consistent with this solicitation (see Sec. 4.3 and 4.5), will be given out by the awarding Air Force directorate along with the Phase I contracts.

PROPOSAL SUBMISSION INSTRUCTIONS

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
	(Name and number for mailing proposals and for administrative questions)	(For contract questions only)
AF99T001 thru AF99T009	Air Force Office of Scientific Research AFOSR/NI 4040 N. Fairfax Dr., Ste 500 Arlington VA 22203-1613 (Chris Hughes, (703)696-7315)	Anne Carroll (703)696-5983
AF99T010	Directed Energy Directorate AFRL/DE 3550 Aberdeen Ave. SE Building 497, Room 239 Kirtland AFB NM 87117-5776 (Bob Hancock, (505)846-4418)	Sam Berdin (505)846-1097
AF99T011	Space Vehicles Directorate AFRL/VS 3550 Aberdeen Ave. SE Building 497, Room 239 Kirtland AFB NM 87117-5776 (Bob Hancock, (505)846-4418)	Francisco Tapia (505)846-5021
AF99T012	Human Effectiveness Directorate AFRL/HE 2509 Kennedy Circle, Bldg 125, Rm 161 Brooks AFB TX 78235-5118 (Belva Williams, (210)536-2103)	Don Norville (210)536-6393
AF99T013	Information Directorate AFRL/IFB 26 Electronic Parkway Rome NY 13441-4514 (Janis Norelli, (315)330-3311)	Joetta Bernhard (315)330-2308
AF99T014	Materials & Manufacturing Directorate AFRL/MLOP 2977 P Street, Rm 418, Suite 13, Bldg 653 Wright-Patterson AFB OH 45433-7746 (Sharon Starr, (937)656-9221)	Terry Rogers (937)255-5830 Bruce Miller (937)255-7143
AF99T015	Munitions Directorate AFRL/MNOB 101 West Eglin Blvd, Suite 140 Eglin AFB FL 32542-6810 (Dick Bixby, (850)882-8591x1281)	Lorna Tedder (850)882-4294,x3399

AF99T016	Propulsion Directorate AFRL/PROP 1950 Fifth Street, Building 18 Wright-Patterson AFB OH 45433-7251 (Dottie Zobrist, (937)255-6024)	Kathy Walston (937)255-5310
AF99T017	Sensors Directorate AFRL/SNOX 2241 Avionics Circle, Bldg 620, Rm N2S24 Wright-Patterson AFB OH 45433-7320 (Marleen Fannin, (937)255-5285, x4117)	Michele L. Dickman (937)255-5311
AF99T019	Air Force Office of Scientific Research AFOSR/NI 4040 N. Fairfax Dr., Ste 500 Arlington VA 22203-1613 (Chris Hughes, (703)696-7315)	Anne Carroll (703)696-5983

FY99 AIR FORCE STTR TOPICS

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, ARLINGTON VA

AF99T001	Integrated Quantitative Nondestructive Evaluation (QNDE) and Reliability Assessment of Aging Aircraft Structures
AF99T002	Gigawatt-Level
AF99T003	Development of Quasicrystal Coatings as Materials for Next Generation Weapons Systems
AF99T004	Automated Data Processing for Non-stationary
AF99T005	Revolutionary Propulsion / Structural Concepts for Microsatellites
AF99T006	Corrosion Rates in Aircraft
AF99T007	Active Control of Complex Weapons' Bay Oscillations
AF99T008	Quantum-Dot Flat-Panel Displays
AF99T009	Ultra-High-Speed Mobile Communication and Space-based Networks

AIR FORCE RESEARCH LAB – DIRECTED ENERGY DIRECTORATE, KIRTLAND AFB NM

AF99T010 Material Development for Large

AIR FORCE RESEARCH LAB – SPACE VEHICLES DIRECTORATE, KIRTLAND AFB NM

AF99T011 Technologies for Clusters of Microsatellites

AIR FORCE RESEARCH LAB – HUMAN EFFECTIVENESS DIRECTORATE, BROOKS AFB TX

AF99T012 Tools and Techniques for Establishing and Maintaining a Common Frame of Reference During Distributed Meetings

AIR FORCE RESEARCH LAB – INFORMATION DIRECTORATE, ROME NY

AF99T013 Crisis Action Planning

AIR FORCE RESEARCH LAB – MATERIALS & MANUFACTURING DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF99T014 Improved Processes for Microstructural and Nanostructural Engineering

AIR FORCE RESEARCH LAB – MUNITIONS DIRECTORATE, EGLIN AFB FL

AF99T015 Munitions Research

AIR FORCE RESEARCH LAB – PROPULSION DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF99T016 Innovative Propulsion and Power Synergisms

AIR FORCE RESEARCH LAB – SENSORS DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF99T017 Multi-Discriminant Sensing From High Altitude Or Space

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, ARLINGTON VA

AF99T019 Advanced Analysis Methods for Aeroelastic Design of Fixed Wing Vehicles

Department of the Air Force
FY1999 STTR Topic Descriptions

AF99T001 TITLE: Integrated Quantitative Nondestructive Evaluation (QNDE) and Reliability Assessment of Aging Aircraft Structures

TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: To develop new NDE technology based on the correlation of probabilistic damage and failure assessment and QNDE of aging aircraft structures.

DESCRIPTION: The aging of military aircraft has long been recognized (1), and the Air Force Structural Integrity Program has been used as a basis for the maintenance and operation of USAF aircraft to reduce the likelihood of structural failure. Since the procurement of new aircraft has been greatly reduced, it is necessary to alter the approach to maintenance of aging aircraft. A detailed description of the problems and solutions based on an in-depth investigation is given in the NRC Report, "Aging of US Air Force Aircraft "(2). This report identifies the most important NDE needs, including damage detection of fatigue cracks under fasteners, hidden corrosion, small cracks associated with WFD, cracks and corrosion in multi-layer structures, etc. A priority 1 solution to these problems is to develop an integrated quantitative NDE capability through "long-term" research.

This STTR topic seeks development of physical models for determining (probabilistic) system response features such as probability of detection (POD) for the specific problems indicated above. These measurement models must be based on first principles and a thorough understanding of damage phenomena, e.g., early corrosion-fatigue transition. New probes and techniques based on these models are to be developed for improving NDE capability. An integrated methodology should not only be critical for developing cost-effective, life-cycle management, but should overcome major NDE technology limitations such as inverse scattering problems in flaw-sizing detection (with limited experimental data).

PHASE I: Develop reliable measurement models for POD-type analysis for specific aging aircraft damage conditions.

PHASE II: Develop new QNDE probes and techniques to improve the detection capability of aging aircraft structures.

PHASE III DUAL USE APPLICATIONS: The NDE instrumentation and technology to be developed under this topic will be valuable to the entire aircraft industry, including airlines, FAA, NASA and DOD.

AF99T002 TITLE: Gigawatt-Level, Overmoded, Slow-Wave Microwave Sources

TECHNOLOGY AREA: Electronics

OBJECTIVE: Demonstrate the ability of microwave sources to operate at the gigawatt power level without pulse shortening.

DESCRIPTION: Research efforts in narrow-band, high-power microwave (HPM) sources are geared towards increased power using relatively compact hardware. Unfortunately, the increase in power is accompanied by a phenomenon known as "pulse shortening." The problem of pulse shortening can possibly be solved by using large diameter (overmoded), slow-wave structures. Under these conditions the fields at the wall surface can be greatly reduced and the electron beam can be located far enough from the walls, Additionally, non-uniform plasma filling might be used for suppression of undesired modes. The researchers will study the operation of a gigawatt-level, overmoded, slow-wave device operating at voltages below 500kv.

PHASE I: Complete a design for a gigawatt-level, overmoded, slow-wave microwave source. Conduct preliminary feasibility experiments along with appropriate computer modeling to validate the underlying physics.

PHASE II: Develop and implement the Phase I design, producing and testing a prototype model. Prototype microwave sources developed during Phase II will be made available to the Air Force.

PHASE III DUAL USE APPLICATIONS: Gigawatt microwave sources with increased microwave energy per pulse could revolutionize particle accelerators, opening up energy regimes that cannot be achieved on reasonable sized scales with present tubes. These sources could also be used for probing deep space, plasma chemistry and environmental applications.

AF99T003 TITLE: Development of Quasicrystal Coatings as Materials for Next Generation Weapons Systems

TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: The objective is to provide quasicrystal coatings that can provide superior tribological properties for a range of Air Force applications.

DESCRIPTION: The Air Force uses solid lubricant materials in a number of different propulsion applications. For example, solid lubricants reduce friction and wear in rolling and sliding contacts and are used to protect against fretting, galling and seizure for stationary components under vibrational loads.

Plasma sprayed coatings of certain quasicrystalline alloys have been shown to produce reasonable friction, low wear and non-stick characteristics over a fairly broad temperature range; i.e. such coatings have demonstrated excellent performance on cookware as non-stick coatings.

PHASE I: The project would concentrate on the development of improved thermal spray and pulse laser deposition (PLD) methods for depositing quasicrystalline coatings of controlled stoichiometry and composition on substrates relevant to end use applications. Feasibility of controlling alloy concentrations and achieving quasicrystalline phases must be demonstrated. Hardness, toughness, friction and wear data should also be used to provide critical feedback data on coating performance and quality. Stability in oxidizing and corrosive environments, and, high and low temperature should also be considered. Characterization will include microstructure and surface chemistry, partitioning and grain size as this will effect performance.

PHASE II: Should address deposition process control and repeatability, end use component testing and evaluation, economic scale-up issues, and a plan for phase III commercialization. Specify that feedback, sensor based process control be considered.

PHASE III DUAL USE APPLICATIONS: Besides aerospace applications in both the military and civilian aviation communities, successful development could result in improved high temperature solid lubricants for high temperature/high efficiency automotive engines and other industrial applications: (wire drawing, metal working, anti-seize coatings etc.).

AF99T004 TITLE: Automated Data Processing for Non-stationary, Multi-scale, Fractal Processes

TECHNOLOGY AREA: Command, Control, and Communications (C3)

OBJECTIVE: Develop user friendly software for the analysis of non-stationary, multi-scale fractal processes.

DESCRIPTION: The Air Force is interested in non-stationary, multi-scale, fractal processes because, among other reasons, atmospheric turbulence data and data on laser propagation through turbulence exhibit these characteristics. Such data is key to the design and performance predication for laser and imaging systems which operate in the atmosphere. A primary system of interest is the Airborne Laser System (ABL). The aforementioned data are by their nature non-stationary or at least multi-scale stochastic processes which frequently exhibit power law behavior. Usually the signal of interest is embedded in considerable noise. We seek user friendly software which captures the relevant analysis techniques for such processes. This software should be capable of extracting power law and other parameters from the data, and assign confidence intervals etc. to the estimates. The procedures should be robust to data segmentation, and handle the inherent non-stationary in spite of short and noisy data segments. It is envisioned that the software will be used to analyze scientific data, and also form a core for a battlefield system which could use in-situ meteorological and other observations to assist in battlefield decision making for ABL employment.

PHASE I: During Phase I the contractor will review statistical techniques for the analysis of non-stationary and power law processes, and propose a family of methods to be captured in software. Additional analysis will be performed as necessary, to tie the methodologies together into a meaningful framework for automated, robust analysis of such data. A software design will be proposed for capturing these methodologies in a user friendly architecture as a MatLab Toolbox.

PHASE II: Phase II will develop, test, and deliver a documented user friendly software package which captures the analysis techniques of Phase I in a MatLab Toolbox. An instruction manual will be prepared and a three day instruction course will be offered to personnel selected by the government. The course will cover the analysis techniques and their software implementation.

PHASE III DUAL USE APPLICATIONS: A MatLab Toolbox which captures the state of the art in non-stationary or multi-scale time series analysis, with particular application to power law processes, will find wide applicability in the geophysical community where much of the data is of this form. It will be immediately valuable to DOD community who use atmospheric data for imaging and laser system design. The package will also be of use to the financial community, since once again their time series are frequently non-stationary and of multi-scale power law type.

AF99T005 TITLE: Revolutionary Propulsion / Structural Concepts for Microsatellites

TECHNOLOGY AREA: Aerospace Propulsion and Power

OBJECTIVE: Investigate revolutionary propulsion concepts such as self-consuming satellites using propellant as load bearing structures. Since propellant will serve dual-purpose, thrust matter and structural material in these concepts, the research activity will require multidisciplinary approach in order to meet the objectives of this topic

DESCRIPTION: The development of low-cost, single-function microsatellites offers new horizons for military applications, when the microsatellites operate cooperatively either in clusters or in constellations. The mission is accomplished by a fleet of several smaller microsatellites, rather than launching a single large spacecraft, with the payload distributed among the micro-craft to reduce the mission risk. Loss of one microspacecraft would not eliminate the entire operation. Furthermore, launch costs may be reduced significantly as a result of substantially reduced spacecraft masses. The traditional approach in designing satellites is to structurally stiffen the satellite so that it will survive during the launch environments; once on-orbit, the satellite structure mass is no longer needed. This approach is a very inefficient way to design satellites, considering the fact that a kg of mass costs tens of thousands of dollars to put into space. Therefore, it is necessary to devise different ways to structurally stiffen the satellite. One such concept is to have the propellant a part of the satellite stiffening element to provide structural and dynamic stability. Weight and volume reductions in the satellite will be accomplished by using the propulsion system's propellant as part of the load-bearing structure of the satellite. This research should examine sublimating solid propellant thrusters such as pulsed plasma thruster, ion and free molecule thrusters, laser or microwave supported propulsion systems, solid-fueled chemical thrusters and light weight casing at microscales, understand micro-plasma dynamics, identify scaling laws and model subject thrusters and propellant feed systems at microscales, develop stable and reliable MEMS scale pressure and mass flow rate measurement techniques. However, these models should also incorporate structural properties of propellant material, and investigate how propellant behaves under pressure cycling conditions. Understand and predict chemical reactivity and kinetics, time dependent transformations, damage mechanisms associated with fatigue, attachment techniques and material discontinuity, and develop constitutive relations for the heterogeneous propellant material systems. Detailed structural analysis will also be performed on the most promising concepts and a prototype shall be built and tested to verify of the detailed analysis.

PHASE I: Design and test feasibility of the dual-purpose propulsion concepts that can be used as load bearing structures. All propulsion concepts designed for a degrading satellite must still be performance competitive with current propulsion systems.

PHASE II: Develop and test prototype of the concept(s) developed in the Phase I effort.

PHASE III DUAL USE APPLICATIONS: The technologies developed here could be implemented in commercial communications satellites. Availability of these technologies could provide cost- and weight-effective architectures for future implementations of these systems

AF99T006 TITLE: Corrosion Rates in Aircraft

TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: Determine the rate at which corrosion damage accumulates in various aerospace structures.

DESCRIPTION: In order to control Air Force maintenance costs and ensure aircraft structural integrity, it is imperative to determine the rate at which corrosion damage accumulates in various aerospace structures. Similarly, progressive corrosion damage information is important for assessment of airframe structural integrity. Currently, there are only limited techniques for quantifying corrosion kinetics, none of which are suitable for quantifying the rate of hidden corrosion in lap joints or exfoliation corrosion in thick wing skins or structural members. A promising method involves the use of superconducting quantum interference device (SQUID) magnetometers to image the magnetic fields associated with hidden corrosion activity.

The goal of this STTR topic is to demonstrate the feasibility of developing new laboratory techniques incorporating supersensitive SQUID magnetometers which will be suitable for quantifying corrosion kinetics in aircraft aluminum alloys. Damage mechanisms to be examined include general, filiform, exfoliation and fretting corrosion, and stress corrosion cracking. Systems to be examined include lap joints, wing skins, and structural members.

PHASE I: Analyze the existing techniques for measuring the rate of hidden corrosion, and make a comparison of the proposed method with existing techniques.

PHASE II: Develop an advanced prototype laboratory instrument for monitoring hidden corrosion in test samples, and provide the validation of the new corrosion-monitoring techniques via both measurement and data analysis.

PHASE III DUAL USE APPLICATIONS: The corrosion activity monitoring instrumentation developed under this topic will have value not only to the Air Force logistics community will be equally valuable to airplane manufacturers and to commercial airlines.

AF99T007 TITLE: Active Control of Complex Weapons' Bay Oscillations

TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: Characterize the nonlinear instability wave interactions that occur in compressible, flow-induced cavity oscillations. Develop tools for prediction of these interactions and a system for effective real-time, active feedback control of multi-mode interactions. Demonstrate real-time, feedback control in wind-tunnel tests.

DESCRIPTION: Cavity oscillation due to nonlinear instability wave interactions in Air Force Air aircraft caused by weapons bays, wheel wells, and sensor bays are a significant problem in the high-speed environment. To date, active flow control has been restricted to control of single-frequency instability waves. Fluid flows are inherently nonlinear, leading to complex interactions between the primary instability wave and its related harmonics. Cavity oscillations are further complicated by the presence of multiple modes of oscillation that are not harmonics of each other but still interact. In order to make active flow control suitable for real-world AF internal weapons bay aircraft, nonlinear interactions must be characterized and modeled. Then, novel actuation and real-time, feedback control algorithms can be developed. This topic seeks proposals to develop suitable computational tools and feedback control systems. The technical challenges offered in this topic include (1) characterizing dynamic nonlinear environments, (2) modeling the resulting nonlinear instability wave interactions, (3) devising an effective means of intelligent control of these interactions in real-time, and (4) demonstrating the control in a wind-tunnel test. The long-range goal is an active-control "toolkit" that allows one to devise realistic flow-control systems in rapid fashion. Multi-disciplinary approaches for this topic are encouraged, combining, for example, novel experiments and computational tools, smart structures for actuator development, and advanced signal processing algorithms for system identification and control. The envisaged work plan will include the following tasks.

PHASE I: Characterize and model nonlinear interactions in flow-induced cavity oscillations. Develop a prototype real-time, feedback control scheme combining suitable actuators, sensors, and control algorithms.

PHASE II: Further develop and validate the feedback control system and modeling scheme using wind-tunnel tests. Integrate the experimental and computational tools into a rapid prototyping flow-control toolkit. Such a toolkit will enable reliable flow-control methods to be rapidly applied to practical fluid dynamic problems.

PHASE III DUAL USE APPLICATIONS: An active control toolkit meeting the criteria would have several commercial and military customers. Applications in commercial and AF systems would include: (1) control of oscillations in weapons, landing gear, and instrument bays, (2) control of separation on control surfaces in military and commercial aircraft, and (3) control of flow-induced noise in turbomachinery and automobiles.

AF99T008 TITLE: Quantum-Dot Flat-Panel Displays

TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: Develop flat-panel displays based on ordered arrays of electroluminescent quantum dots

DESCRIPTION: Display technology is a ubiquitous Air Force requirement. Displays often control information acquisition, which impacts the speed and effectiveness of decision making, and they are essential for situational awareness and control of the battle space. The dominant display technologies currently are cathode ray tube (CRT) and liquid crystal displays (LCDs). However, CRTs require vacuum and cannot practically be built to large scale because of their weight and bulk. LCDs employ a complex and expensive fabrication process to produce high resolution, require backlighting, and have a limited viewing angle. Conventional electroluminescent (EL) display is the only technology used in flat panels, which is totally solid-state and free of a vacuum enclosure. It is intrinsically rugged, has a wide operating temperature range, has no viewing angle problems, and is very bright. However, multi-color performance is poor, and it requires a high voltage (~100 volts) for excitation/addressing, which adds to its cost and makes it unsuitable for numerous applications.

Quantum-dot EL displays have the advantages of a conventional EL display while overcoming the problems that have limited the widespread application of conventional EL devices. A quantum-dot display will achieve multicolor emission from the same material by employing quantum dots (as emissive elements) of varying diameters (where "size =color"). Such a display system can be passively driven by low voltages (~10 volts) which eliminate the need for expensive active addressing schemes. In addition, such a device will have low-power consumption.

Quantum-dot devices address the following Air Force needs: all solid-state and intrinsically rugged, wide operating temperature range; low voltage (~10 volts); high internal quantum efficiency; highly non-linear response; sunlight readable; compact and lightweight; ultra-thin and deployable on flexible substrates. Examples of applications include ergonomic head-mounted displays for Air Force pilots and for immersive virtual reality, flexible displays, and large-area displays for command and control. These examples indicate the need for a highly scaleable quantum-dot display technology.

PHASE I: Design a highly scaleable method for producing quantum dots that will be suitable for EL devices, and demonstrate the feasibility of the technique to produce ordered arrays of quantum dots.

PHASE II: Perform optical characterization of fabricated quantum-dot arrays. Demonstrate a monochrome display prototype, which can be electrically pumped. Demonstrate the feasibility for producing a multicolor quantum-dot display.

PHASE III DUAL USE APPLICATIONS: Broadly speaking, display applications can be categorized as industrial/commercial, military and consumer with shares of 72%, 18%, and 10%, respectively, totaling an estimated $60 billion worldwide market in 1995 (Ref 1, pp.3-4). Among the numerous applications in commercial and Air Force systems would be helmet-mounted displays (HMDs) for immersive virtual reality, flexible displays, and large screen displays for command and control functions.

AF99T009 TITLE: Ultra-High-Speed Mobile Communication and Space-based Networks

TECHNOLOGY AREA: Command, Control, and Communications (C3)

OBJECTIVE: Objective is to solve problems of information representation and transmission and thereby accelerate the development of highly dependable and available high-speed communication networks to the Services.

DESCRIPTION: Laser pulse widths of 5 Femtoseconds (five one-millionths of a nanosecond) have been demonstrated in the laboratory. Data links at 1 Terabit per second (one million Megabits) over optical fiber, at one error bit per billion, have also been achieved. Fiber rates of 10-40 Gigabits/sec are becoming commercially available, as are new local area networks (LANs) delivering a Gigabit per second or more (the 1 GB Ethernet). Future high-speed global internetworking for the Military should effectively utilize these ultra-fast media whenever possible to deliver Ultra-High-Speed communications with high reliability. Ultra-High-Speed links are needed to support the multiplexing of many different users connected to the Global Internetwork via a variety of physical media links transmitting and receiving multimedia data. Single users constitute a large part of the (RF link) Global Internetwork; and current reliable wireless transmission rates are on the order of several Megabits/sec as proposed for third generation commercial cellular systems. This rate needs to be sustainable for military use over a Wide-Area Network that utilizes a diversity of links: co-axial cable, fiber, and laser channels. To achieve this Global Intemetworking conception, concentrated effort is required in several specific areas. The use of parallel optical computing systems to exploit temporal-to-spatial waveform conversion ('twavelength division multiplexing") holds great promise for both encryption and achieving faster rates. Space-time coding can be very effective in facilitating reliable reception rates in wireless "fading" environments, and for alleviating multi-path effects. Joint "semi-blind" equalization and interference cancellation, relying on short training sequences and ingenious use of antenna arrays, is a promising innovation. Attention must be paid not only to "physical layer" optimization but also to the incorporation of link layer models to achieve needed rates over power and band-limited channels.

As analog-to-digital converters operating at 1 GHz or higher become commercially available, new real-time signal processing schemes are required in Software Radio and should be phased into military platforms. Space assets will be the backbone of the 3rd Millenium Global Network. Issues in channel allocation and control, hand-offs, LEO-to-GEO transmission/reception, and power amplifier linearization must be resolved before full exploitation of Space can be achieved. Multi-rate, multiple-access transmission policies must be investigated further, with emphasis on CDMA, TDMA and multicarrier hybrid policies. A critical issue is robust implementation of the (Wireless) CDMA to (Global Network) ATM link. Waveform design for covertness and encoding for error-tolerance must be integrated with the large-scale mobile networking strategy.

Preference will be given to proposals that show- consideration of the global communications picture beyond the province of specialized technology improvement. Familiarity with applications and methodologies of importance to the Air Force is essential, as is a convincing road map or plan for technical insertion of results.

PHASE I: Extend the state-of-the-art in one or more critical communication areas, with published foundational results. Develop a simulation or initial application resident on a microcomputer to demonstrate feasibility.

PHASE II: Develop a realistic communication framework based on the methodologies from Phase I. Extend the framework and attendant algorithms to deal with several of the combat-related disruptions and battlespace stress to be placed on a mobile network. Perform rigorous instantiation and testing using real-world field data.

PHASE III DUAL USE APPLICATIONS: Digital personal communications is now an exploding area of commercial enterprise. Advances achieved through DoD research programs have entered into the commercial sphere, stimulating the economy and fostering the industrial base for superiority in conflict. With projected use of commercial satellites and commercial off-the-shelf (COTS) components in the Global Grid, a dynamic synergy between military needs and private sector capability is emerging.

AF99T010 TITLE: Material Development for Large, Deployable, Space Optics

TECHNOLOGY AREA: Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop novel materials and processes for the fabrication of large optical quality membrane mirrors.

DESCRIPTION: AFRL has demonstrated that thin film polymeric membranes are potentially a valid technology for a large concave mirror when used with a real-time holographic correction scheme. Pressure is used to create the doubly curved mirror. The membranes on these large apertures range in thickness from 10 micrometers to 150 micrometers and are coated with 800 Angstroms to 1000 Angstroms of aluminum. This technology is well suited for deploying an optical system into space, since the membranes can be packaged on the ground and erected after deployment in space. Membranes as large as one meter are currently made, but larger membranes are required. Scaling membrane materials to larger sizes challenges and may eliminate technologies used for one-meter pieces. Research and development of new material systems and fabrication processes suitable for 8-meter, optical quality, membranes need to be developed. This STTR topic is focused on the research and development of 8-meter and larger, optical-quality membranes. The thickness, isotropic properties and the homogeneity of the membrane must be held to a very tight tolerance. The wavefront phase error introduced over the entire aperture must be limited to less than five micrometers. The material properties can be derived from this wavefront error specification. The membrane must maintain its optical properties for five years when placed in an environment similar to a geosynchronous orbit around the earth. After five years, the phase error as described above should be maintained below 10 micrometers.

PHASE I: The contractor shall identify a material system and fabrication process suitable for optical quality, large membrane mirrors. The contractor shall perform research and development to demonstrate the feasibility of the chosen material system and fabrication process by fabricating an optical quality membrane prototype. Optical testing will require an aluminum coating on the membrane. Complete characterization of the material's mechanical and optical properties is required. The contractor shall use data collected during Phase I to demonstrate scalability to an 8 meter diameter and larger membrane.

PHASE II: The contractor shall continue development of the membrane material system and fabrication process researched in Phase I. The contractor shall develop and demonstrate process necessary to scale the membrane to sizes larger than 8 meters in diameter. Such a capability does not currently exist. The contractor shall demonstrate the feasibility of the advanced process by fabricating, testing and characterizing at least a 3-meter membrane. The contractor shall use data collected during Phase II to demonstrate scalability to membranes larger than 8 meters in diameter.

PHASE III DUAL USE APPLICATIONS: Optical quality membranes provide lightweight, small volume mirrors for space optical systems. These commercial systems range from astronomical telescopes to communications. Terrestrial applications include large holographic systems and telescopes.

REFERENCES:
1. D. K. Marker and C. H. Jenkins, "Surface precision of optical membranes with curvature," Optics Express, Vol. 1, No. 11, 24 November 1997.
2. W, Z, Chien, "Asymptotic behavior of a thin clamped plate under uniform normal pressure at very large deflection," Sci. Rep. Natn. Tsing Hua Univ. A5, 71-94 (1948).
3. R, Kao and N Perrone, "Large defections of axisymmetric circular membranes," Int. J. Solids Struct. 7, 1601-1612 (1971).

AF99T011 TITLE: Technologies for Clusters of Microsatellites

TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: Develop architectures, concepts, and hardware for low cost, lightweight microsatellites which enable distributed, collaborating clusters.

DESCRIPTION: Trends towards less costly approaches to meet mission requirements have generated new architectures for space systems. One such novel concept is the idea of collaborating clusters, or swarms, of microsatellites (10-100 kg) flying in close formation working cooperatively to do the job of a larger, more complex satellite. Notional missions for these clusters include radar, communications, navigation, and passive radiometry. For this approach to be cost effective compared to the traditional large satellite approach, the satellites must be low cost and light weight while having significant capabilities in terms of power, computation, data storage, communications data rates, etc. In addition, the satellite swarm must be highly autonomous, reconfigurable, and adaptable. For example, a microsatellite which generates 1 kW of power, hosts a 1 GFLOP signal processor, has a communications link at 250 Mbps, and costs not more that $5M in quantities of 100's, could enable clusters which perform a space-based radar mission affordably.

This research topic is intended to explore and develop concepts for distributed satellite systems, develop lightweight and low cost satellite component and subsystems compatible with capable microsatellite cluster, and/or investigate issues of autonomy and cost effective operations of clusters.

PHASE I: Explore architectures, concepts and technologies which will enable microsatellite cluster. Using a system approach, quantify the benefits of the selected technologies for a notional system design. Where appropriate validate key technology concepts by analysis or limited component testing. Plan the Phase II effort.

PHASE II: Develop a proof of concept prototype of the selected key technology. Demonstrate its performance and validate its key metrics. Verify by extrapolation that the performance, cost, and/or advantages will be achieved in a full system application.

PHASE III DUAL USE APPLICATIONS: The technologies developed here could be implemented in commercial LEO communications satellites. Availability of these technologies for large LEO constellations could provide cost- and weight-effective architectures for future implementations of these systems. The military is also developing plans that would involve microsatellite clusters for communications and remote sensing.

REFERENCES:
1. Cobb,R., Das, A., and Stallard, M, "TechSat21 - Space Missions Using Collaborating Constellations of Satellites," AIAA/Utah State University Conference on Small Satellites, Paper SSC98-VI-1, 1998.
2. Helvajian, H., Janson, S. W., and Robinson, E. Y., "Big Benefits from Tiny Technologies: Micro-nano Technology Applications in Future Space Systems," Critical Reviews of Optical Science and Technology, Vol CR66, SPIE, pp 3034.

AF99T012 TITLE: Tools and Techniques for Establishing and Maintaining a Common Frame of Reference During Distributed Meetings

TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop an integrated system of models, tools, and procedures to establish, maintain, and assess a common frame of reference (common operating picture) during distributed (virtual) meetings in the context of coalition operations and information warfare.

DESCRIPTION: Today, the Air Force's operational environment is centered on a highly distributed, highly integrated joint theater architecture often as a member of a coalition force. This environment places a tremendous premium on effective communication between geographically separated, culturally diverse staff and command elements. Routinely this communication covers a multitude of complex ideas such as operational goals and requirements, force structure status and modification, and course of action options with the aim of making the optimal decision which is then understood and effectively enacted. A critical component of this communication process is ensuring, to the highest degree attainable, that all participants have, and maintain, a common understanding, or frame of reference, of the topic(s) under discussion, i.e. that everyone is "on the same page." It is important to understand the critical cognitive components involved in attaining and maintaining this common picture in a distributed multi-cultural environment such as found in a conference call or video tele-conference between joint and coalition partners. Once these components are identified it would be of interest to identify the most effective means of detecting when a misperception has occurred and to assess its effect on the course of the discussion or decision. Finally, an identification and understanding of potential remedial actions, and the mechanism(s) by which they could best be implemented, to restore a communication breakdown resulting from a misperception of data or a statement, back to full effectiveness is of great interest and would serve as an integral part of our ability to attain and maintain an effective communication under these conditions.

PHASE I: Conduct a comprehensive analyses of the effects of distributed communication, such as conference calls or video tele-conferences, have on achieving and maintaining a common frame of reference for a discussion of a complex topic. Emphases will on identifying an assessing the impact of those factors most likely to interfere with effective distributed communication in a multi-cultural environment. The findings of this Phase 1 effort will be documented in a technical report.

PHASE II: Develop and conceptually demonstrate a suite of assessment and remediation tools/techniques which can identify a lack of a common frame of reference during a discussion as described in Phase 1 and chart a series of potential corrective actions. A final technical report will document all progress and a completed working model of the analysis and design of a system integrating the results of Phases I & II will be delivered.

PHASE III DUAL USE APPLICATIONS: This technology has great potential for use in today's ever growing "Global Economy." Application of this technology would not be limited to any specific business sector, but would be an enabling technology to all corporations/businesses engaged in international trade.

REFERENCES:
1. Wellens, A.R. (1993). Group situational awareness and distributed decision making: From military to civilian applications. In N.J. Castellan, Jr. (Ed.), Individual and group decision making; 1997.
2. Johnson & Libicki (eds.) (1995). Dominant Battlespace Knowledge: The Winning Edge, Washington DC: National Defense University

AF99T013 TITLE: Crisis Action Planning, Scheduling, Execution Monitoring, and Management System for Humanitarian Assistance and Disaster Relief

TECHNOLOGY AREA: Command, Control, and Communications (C3)

OBJECTIVE: Provide enhanced military and civilian protection by providing in near real time the planning, scheduling, execution monitoring, and management system that would provide the critical link between detection and protection for a given Biological and Chemical (B&C) battle-space.

DESCRIPTION: Joint Forces including military and civilian organizations need to safely operate, survive, and sustain operations in a Biological and Chemical (B&C) agent threat environment. Five B&C joint future operational capabilities have been identified in the following areas: B&C Battle Management, Contamination Avoidance, Individual Protection, Collective Protection, and Restoration. The umbrella technology area is centered around B&C Battle Management which can address many of the needs identified. This will be accomplished by a mixed initiative (Human/Machine Interface) approach to support feasible solutions in near real time during times of crisis.

Individual Protection: Medical support has limited capabilities to provide prophylaxes, antidotes, treatments, vaccines, and casualty management systems to and for B&C casualties. There is no theater-wide medical surveillance system. Technologies developed under this effort should help the Joint Force Commander and his staff determine available resources, trade-off different Courses of Action (COA) based on supplies, facilities, and personnel and then schedule the right resources to the threat identified in the most timely and efficient manner.

Collective Protection: Deployable collective protection is labor intensive for transport, set-up and takedown. Size, power, and ECU requirements result in unacceptable logistics burden. Fixed collective protection is not easily relocatable or repairable. This is a classic problem that scheduling and planning tools are addressing for military operations. Technologies developed under this effort would focus on the special needs and requirements for B&C threats.

Restoration: Decontamination systems and decontaminants are not effective against some B&C agents; are degrading/damaging to the contaminated operational material; and are not effective against some. Developing the proper knowledge bases and applying them appropriately in the mission planning, COA, scheduling system will allow the commander and his staff to determine the best COA to protect personnel and resources. This effort would develop tools and technologies to address these specific needs.

PHASE I: Perform preliminary investigation into technologies and tools and determine their feasibility in meeting the objective of this effort. The solution should use standards-based, commercial off-the-shelf (COTS), Geographic Information System (GIS), and client/server software (i.e. Web server and browser) and be capable of supporting the entire spectrum of operations. Cost, benefit, risk, and other related technical concerns shall be addressed.

PHASE II: Develop and demonstrate the prototype tool(s) or technologies on a feasible scenario appropriate for both military and civilian applications. Metrics such as time to complete task, completeness of the result, level of uncertainty, and others shall be documented showing capability and effectiveness of the proposed tools, technology, or system.

PHASE III DUAL USE APPLICATIONS: The B&C Battle Management process has a large component of planning which can be solved by manual planners with the support of computer supported resource allocation and scheduling. A fully automatic or semi-automatic computer planning system for even small scale military planning problems are stressing the current state-of-the-art in mission planning, re-planning, and scheduling in near real time. This is a result of the difficulty in representing the knowledge of the particular problem and focusing the planner to promising search areas or alternatives in the planning, re-planning, scheduling, and course of action (COA) areas.

REFERENCES:
Humanitarian Assistance and Disaster Relief in the Next Century CCRP Workshop Report, October 28-30, 1997.
Defense Science Board 1997 Summer Study Task Force, • DoD Responses to Transnational Threats", October 1997.

AF99T014 TITLE: Improved Processes for Microstructural and Nanostructural Engineering

TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Develop improved processes for engineering materials and structures at the microscopic and nanoscopic levels.

DESCRIPTION: Materials properties depend strongly on the microstructure or in some cases the nanostructure of the material. The advent of techniques to both measure (image) microstructure as well as to manipulate it during material formation has lead to a wide range of revolutionary materials. Examples include semiconductor quantum well-based structures grown by molecular beam epitaxy (MBE); micro-electromechanical systems (MEMS); optical waveguides from block copolymers; precipitation hardened aluminum alloys; ordered ceramic and semiconductor structures from organic templates; and smart structures and materials (materials that sense their surroundings and react accordingly). These new materials have many potential applications that address future Air Force requirements.

Continued advances in the area of microstructural engineering will depend upon the ability to measure both the structure and the composition at the microscopic (or even molecular or atomic) level. The development of new materials characterization techniques, both ex-situ and especially in-situ, will be considered under this topic. These must provide a new or improved (increased precision and accuracy) measurement capability.

An improved knowledge of the relationship between materials microstructure and materials properties is required in order to determine the optimum microstructure for a given material or application. This can be determined either experimentally or by theoretical/computational approaches.

A further requirement is an increased ability to control the processes by which these materials are formed. Improved synthesis, or novel processing methodologies, which provide a greater control over the microstructure as it forms are of primary importance. In particular, these new processes should be able to control the microstructure formation at smaller length scales and with improved uniformity (or tailorability) throughout the material. In some cases, both structural and stoichiometric control will be required.

Candidate materials/processes for this topic should address materials applications of interest to the Air Force, which include electro-optic, MEMS, organic, ceramic, composite, metallic, intermetallic, and nano-materials.

PHASE I: The goal of Phase I is to demonstrate an improved ability to measure or control materials microstructure. An alternate but important goal would be to demonstrate improved materials performance through microstructural engineering or new materials synthesis. New characterization tools must be shown to provide a new capability or to be an improvement over existing tools. New processes and techniques must demonstrate an increased ability to control and manipulate microstructure, or yield entirely new (and promising) microstructures and materials.

PHASE II: The goal of Phase II is to develop a marketable product. This could be a new characterization tool, process equipment and techniques for microstructure control or an improved material with an engineered microstructure.

PHASE II DUAL USE APPLICATIONS: This topic addresses a wide range of potential commercial applications, including electronics, electrooptics, structural materials, sensors, drug delivery, gas separation and others.

REFERENCE: Science, v. 277, 29 Aug. 1997, pp. 1183, 1213-1253

AF99T015 TITLE: Munitions Research

TECHNOLOGY AREA:

OBJECTIVE: Develop innovative concepts in areas associated with air-deliverable munitions and armaments.

DESCRIPTION: The Air Force Research Laboratory Munitions Directorate's mission is to develop, integrate, and transition science and technology for air-launched munitions for defeating ground-fixed, mobile/re-locatable, air and space targets to assure the preeminence of US air and space forces.

a. The Assessment and Demonstrations Division is seeking new and innovative ideas in areas that include highly-agile air-to-air missile concepts, air-to-surface munition concepts, such as unitary penetrators, dispensers, submunitions, and projectiles. Technologies under consideration include aerodynamic shaping, advanced structural/material designs, innovative flight controls which can be integrated into future space delivery platforms and unmanned flight vehicles. Other key areas of interest include time-critical target defeat, bomb-damage identification, and counterweapons of mass destruction. Modeling and simulation tools of interest include high-fidelity physics-based codes for warhead design and penetration analysis, engineering-level tools for weapon/target interaction analysis, and system-level analysis for theater- level modeling. New concept and innovative tools are sought for system-level evaluations, the prediction of functional relationship of fire and/or blast effects on fixed structures, and dispersion of chemical/biological neutralization agents in a high-temperature environment. Commercial dual-use applications for innovative flight vehicle technologies could improve air vehicle performance, as would air foil products, i.e., wind turbines, turbomachinery, etc. Simulations of effects would reduce test costs and provide greater capability for safety officials and insurance underwriters to assess associated hazards. Improved simulation models could benefit commercial building demolition, safety-related assessments, auto safety research, explosives research, mining, drilling, and a wide range of product analysis and evaluation activities.

b. The Advanced Guidance Division seeks new concepts in areas associated with closed-loop guidance of autonomous munitions including inertial sensors, antijam GPS, and terminal seekers, including electro-optical (I2R and LADAR), millimeter-wave, and synthetic aperture radar seeker technology, and the components thereof, and the signal/image/data processing used in such areas. Algorithm/software concepts of interest include (1) guidance software, including guidance laws, estimators, autopilots, and AJGPS software, (2) innovative signal and image processing algorithms for use within autonomous target acquisition (ATA) applications, and (3) operations/functions associated with the ATA process involving noise elimination, detection, segmentation, feature extraction, classification, and identification. Algorithms capable of processing/fusing multi-sensor data are of interest. Fundamentally new approaches to closed-loop autonomous guidance based on biomimetic principles are of particular interest. Commercial dual use applications for these include sensors, processors algorithms applicable to medical imaging, commercial aviation (adverse weather penetration), remote sensing and surveillance.

c. The Ordnance Division is seeking new and innovative ideas/concepts to support the development of advanced warheads, fuzes, and explosives for use in air-delivered conventional munitions to defeat ground, mobile, air targets, as well as above-ground and buried structures. Technologies developed should ultimately result in new and innovative components which are needed to meet the complex future munitions requirements for general-purpose bombs, penetrating warheads, submunitions, safe-arm-fire devices, explosive detonators, explosives and advanced energetic materials, and devices for collecting data to be used in warhead design and analysis. Technologies for defeating weapons of mass destruction, including biological and chemical agents, and/or access denial to stored weapons, are of interest. Dual use application for these technologies include facility/plant security and monitoring, high speed wireless data transmission, micro-electrical mechanical devices for controls and collision avoidance, high powered energy storage devices (capacitors and batteries) and environmentally responsible recycling of energetics and other materials.

PHASE I: Determine the technological or scientific merit and the feasibility of the innovative concept.

PHASE II: Produce a well-defined deliverable product or process.

PHASE III DUAL USE APPLICATIONS: Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

AF99T016 TITLE: Innovative Propulsion and Power Synergisms

TECHNOLOGY AREA: Aerospace Propulsion and Power

OBJECTIVE: Develop technologies that exploit couplings and synergisms between aeronautical propulsion, rocket propulsion, power generation, and active flow-field modifications.

DESCRIPTION: The program will improve aeronautical and aerospace design methods by exploiting multidisciplinary collaborative engineering to enhance the performance, system readiness, affordability and reliability of propulsion and power systems. The program will address the couplings that occur between the energy modes that are created in high speed propulsion and the new effects and concepts that arise through the introduction of non-equilibrium energy transfers to improve and control propulsion (rocket and turbine). These non-conventional synergistic approaches are expected to revolutionize aerospace propulsion in the next century. It will be necessary to employ advanced modeling and simulations and to devise sub-system test strategies for risk reduction tests. These simulations and tests will address the proposed innovations or gaps in the technologies that when resolved will provide significant improvements in system performance. Examples of the component systems and innovations that might be addressed are given below.

a. Develop innovative components, manufacturing/processing techniques and integration technologies aimed at doubling existing rocket propulsion capabilities.

b. Assess non-equilibrium plasma assisted re-light subsystems and other propulsion enhancements approaches for improved high altitude long duration unmanned combat air vehicle (UCAV) propulsion system.

c. Perform research and development to assess possibilities of increasing propulsion efficiency by electrically augmented combustion and improved thermal management.

d. Advance aerodynamic, thermal, and mechanical technology of air-breathing compression and secondary gas path systems for gas turbine engines.

The contractor is encouraged to include additional original concepts and approaches to achieve the desired overall system improvements. These improvements should have definite dual use applicability and affordability with the requested reliability. SBIR contributions are anticipated at the component or subsystem levels.

PHASE I: Experimentally or analytically demonstrate the feasibility of the proposed design concept.

PHASE II: Complete the Phase I design and develop a demonstrator prototype. Document the research and development and develop a technology transition and/or insertion plan for future systems and commercial ventures.

PHASE III DUAL USE APPLICATIONS: High performance low cost rocket propulsion systems can increase global market share for space launch opportunities. Innovative solutions for air-breathing propulsion systems and components will directly effect military and commercial aviation through improved performance and lower cost of ownership.

REFERENCES

1. W. Koop "The Integrated High Performance Turbine Engine Technology (IHPTET) Program" , ISABE 97-7175, Proceedings of XIII Int'l Symposium on Air Breathing Engines

2. S. Anghaie, Book of Abstracts, 33rd IECEC, Col Sprinjs, Aug 1998.

AF99T017 TITLE: Multi-Discriminant Sensing From High Altitude Or Space

TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop innovative sensor systems and/or multi-sensor fusion approaches for targeting systems with robust performance in complex environments.

DESCRIPTION: Future weapons systems development will require a balance between the cost of multi-sensor suites and the performance limitations of single sensor technology. This topic will develop the tools needed to assess targeting performance of single sensor systems, multi-sensor systems, and/or fusion algorithms in a laboratory environment. Concepts for sensing multiple discriminant data and exploiting the data for target detection and identification are sought. Sensor suites to obtain the data may include radio frequency (RF) and electro-optic (EO) wavelengths, with associated fusion and ATR processing. Robust and novel sensing and algorithmic approaches are sought. A sensor model should be developed to provide inputs for fusion/ATR research and development and for defining sensor requirements. Utility of sensing the various phenomena associated with a target ensemble should be quantified over varying missions. These missions should include detection/ID of difficult targets (e.g., concealed, obscured, camouflaged, articulated, adverse weather). Novel, remote sensing approaches for targets that are under bridges, under foliage, or even underground are desired. Sensor suite concepts, fusion/ATR concepts, and phenomenology trades/assessments are all aspects of this topic.

PHASE I: Develop the novel sensing approach through quantitative models and/or paper design of a multi-sensor suite that can demonstrate robustness to difficult target set. Evaluate, via models or simulation, improvement in detection and identification probabilities as a function of the number of target discriminants sensed.

PHASE II: Conduct advanced demonstrations of novel sensing techniques using real data. Laboratory demonstrations are desired. Demonstrate feasibility for specific field application for both a military and commercial market. Tools developed during this phase should be compatible with the computer laboratories at AFRL/SN.

PHASE III DUAL USE APPLICATION: Multi-discriminant sensors/ATR/fusion approaches have significant application in the fields of medical imaging, remote sensing, automated manufacturing and inspection, traffic control, and law enforcement.

REFERENCES:

1. "Study Sees USAF Future Based On Esoteric Technologies," Aviation Week Space Technology, 19 August 1996, v. 145, no. 8, p 80-83.

2. "A Systems Engineering Approach to Aircraft Kinetic Kill Countermeasures Technology: Development of an Active Aircraft Defense System for the C/KC-135," AFIT Thesis AFIT Reference AFIT/GSE/ENY/95D-01, ADA306012.

3. "Registration and High Resolution Reconstruction of Multi-Frame Low-Resolution, Aliased Infrared Images," SPIE Passive Sensors Conference Proceedings, April 1996.

4. Wright Laboratory Sensor Technology Branch (WL/AAJT) Home Page (Public Release Articles with Abstracts) at http://www.sensors.wpafb.af.mil.

5. T.D. Ross, L. Westerkamp, E.G. Zelnio, T.J. Burns, "Extensibility and other model-based ATR evaluation concepts," Algorithms for Synthetic Aperture Radar Imagery IV, Proc. SPIE 3070, Vol. 3070.

AF99T019 TITLE: Advanced Analysis Methods for Aeroelastic Design of Fixed Wing Vehicles

TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: Develop innovative computational aeroelasticity methodologies for understanding, predicting, and controlling critical nonlinear aerostructural interaction phenomena. These methodologies should be modular, highly efficient, and incorporate key physics of the aerostructure interaction environment.

DESCRIPTION: The Air Force has launched an aggressive, three-phase program to improve all aspects of design and performance of fixed wing vehicles. Phase I goals in this program include, but are not limited to: a 25% increase in mission range, a 10% reduction in take-off gross weight, a 5% increase in aircraft lethality, and a 10% reduction in acquisition costs. Achieving these goals will require radical departures from current design practices and include: eliminating wind tunnel flutter models, robust identification of critical flight loads, and integration of aerodynamics, structures, and flight controls in initial design synthesis. Technical challenges are numerous and include: orders of magnitude reduction in computational time, highly improved accuracy in flutter speed prediction, modeling of complex geometries with and without external stores, better accuracy in buffet/vibroacoustic response, and better accuracy in predicting flight loads.

Several fundamental aspects of aerodynamics and structures must be better understood before these technical challenges can be overcome. First and foremost, a dramatic improvement in our understanding of aerodynamic nonlinearities in the presence of flexible structures must be achieved, particularity as it relates to the transonic flight regime. Second, structural nonlinearites and their effects on such phenomena as limit cycle oscillation must be thoroughly investigated, understood, and characterized. Third, high fidelity codes tailored for flutter and loads analysis and reduced order modeling methodologies must be developed. These codes should exist within a multidisciplinary integration framework. Significant strides can be made toward achieving the Fixed Wing Vehicle Program goals once these basic research issues have been addressed.

PHASE I: Identify critical physical phenomena to investigate and establish analytical approach and computational framework.

PHASE II: Experimentally and analytically investigate underlying physics and develop computational algorithms.

PHASE III DUAL USE APPLICATION: Incorporate algorithms developed in Phase II into industrial design codes